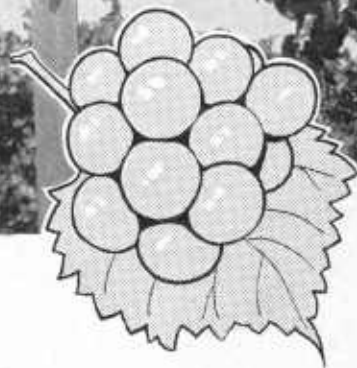
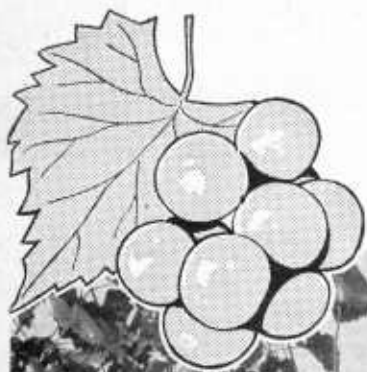


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MUSCADINE GRAPES



Farmers' Bulletin No. 1785



U. S. DEPARTMENT OF AGRICULTURE

MUSCADINE GRAPES, which are native to the southeastern part of the United States, thrive in most soils of that region. They can be grown successfully in the Southeastern States, where American bunch grapes do not thrive. Furthermore, they are suitable for home gardens as well as for commercial use. In fact they are perhaps the most satisfactory of all fruits for the home garden in this region. They cannot be grown, however, where temperatures as low as 0° F. occur habitually and may be injured at somewhat higher temperatures.

Muscadine grapes are relatively uninjured by diseases and insects and produce well with a minimum of care, but they respond favorably to the good cultural practices recommended in this bulletin.

The varieties described or listed produce fruit suitable for making unfermented juice, wine, jelly, and other culinary products and for eating fresh over a long season.

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MUSCADINE GRAPES

By CHARLES DEARING, *associate horticulturist, Division of Fruit and Vegetable Crops and Diseases, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration*

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ADAPTATION

MUSCADINE GRAPES are native to most of the southeastern part of the United States. They thrive in most of the soils of this region, which extends from Virginia to Florida and along the Gulf coast to Texas. Muscadine grapes are used for wine making, but they are also highly prized as fresh fruit by the people of the Southeast and can be made into excellent unfermented grape juice and other culinary products.

In most of the region where muscadine grapes are likely to succeed (fig. 1), the temperature does not often go lower than 10° F. and it rarely goes to 0°. Occasionally vines are found growing beyond these temperature limits, but in such cases they are more or less protected or are not thriving. The minimum temperature that the vines can stand depends largely upon the preceding weather. Although vines have been known to live through periods in which the thermometer registered as low as -10°, they may be damaged at much higher temperatures if the preceding weather has been warm and the change in temperature comes suddenly. Native vines at the northern limits of their range and in the higher altitudes, such as western North Carolina, will stand considerably lower temperatures than vines in the southern coastal section. The muscadine varieties used at present are likely to be killed where temperatures as low as 0° occur habitually and may be injured at somewhat higher temperatures.

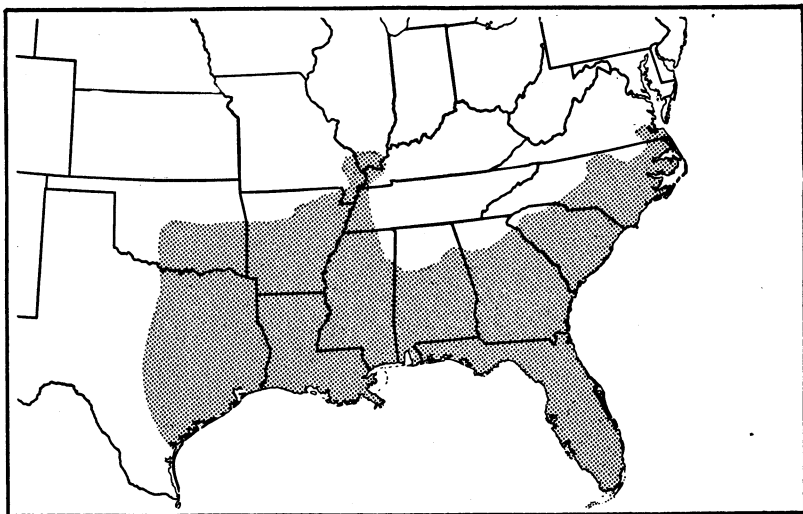


Figure 1.—Map of southeastern United States, showing the region where muscadine grapes are most likely to succeed. This region has a frost-free period averaging 200 days or more, at least 30 inches of rainfall, and rarely minimum temperatures as low as 0° F.

GENERAL DESCRIPTION

The muscadine grapes include two botanical species, *Vitis rotundifolia* Michx. and *V. munsoniana* Simpson ex Munson, of which *V. rotundifolia* is the more important. It is native throughout all the muscadine region except the extreme South, and all the prominent horticultural varieties belong to it. *V. munsoniana* is native only in Florida, on the borders of the Gulf of Mexico, and near the southeastern coast of Georgia. *V. rotundifolia* (fig. 2) bears small clusters of large berries (4 to 10) with large seeds, whereas *V. munsoniana* (fig. 3) bears relatively large clusters of small berries (8 to 30) with small seeds. The vines of *V. munsoniana* are slender and more trailing than those of *V. rotundifolia*, but they do not climb so high. Their leaves are generally smaller than those of *V. rotundifolia*; they have narrow basal sinuses and less numerous but more prominent marginal teeth. *V. munsoniana* has the everbearing habit; in August buds, blossoms, and fruit in all stages of development may be found on the vines at the same time.

The muscadines have hard wood, varying from ashy gray to grayish brown or sometimes yellowish brown. Although the bark adheres closely to the young branches, it sheds annually from the older wood, especially from the trunks of vigorously growing vines. In the young canes the pith is continuous through the nodes. The young wood is covered with numerous small, prominent, warty lenticels. The growing shoots are yellowish or reddish at the tip when young, short-jointed, angled, or sometimes flattened and have intermittent, relatively long, tough, strong, unforked, single tendrils of the same color as the twig on which they are growing. The tendrils may girdle

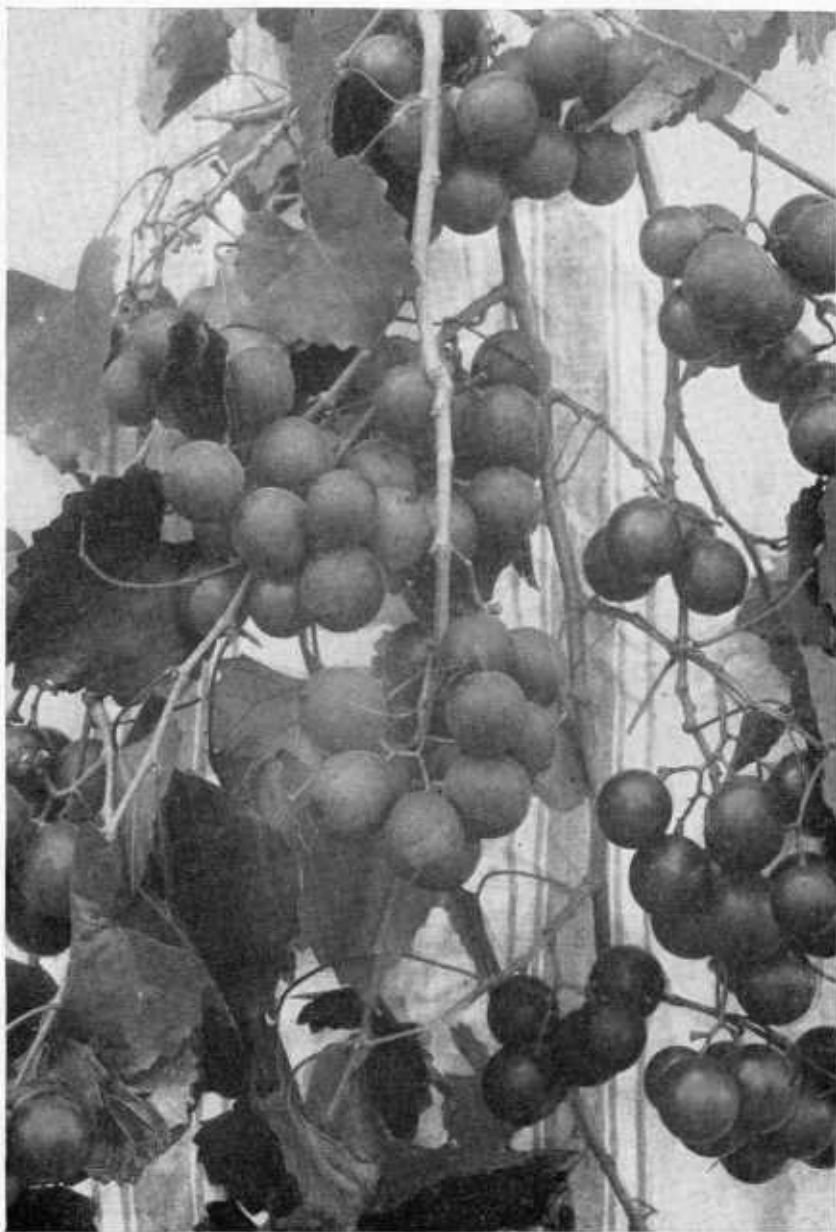


Figure 2.—Fruit and branches of *Vitis rotundifolia* (about half natural size).

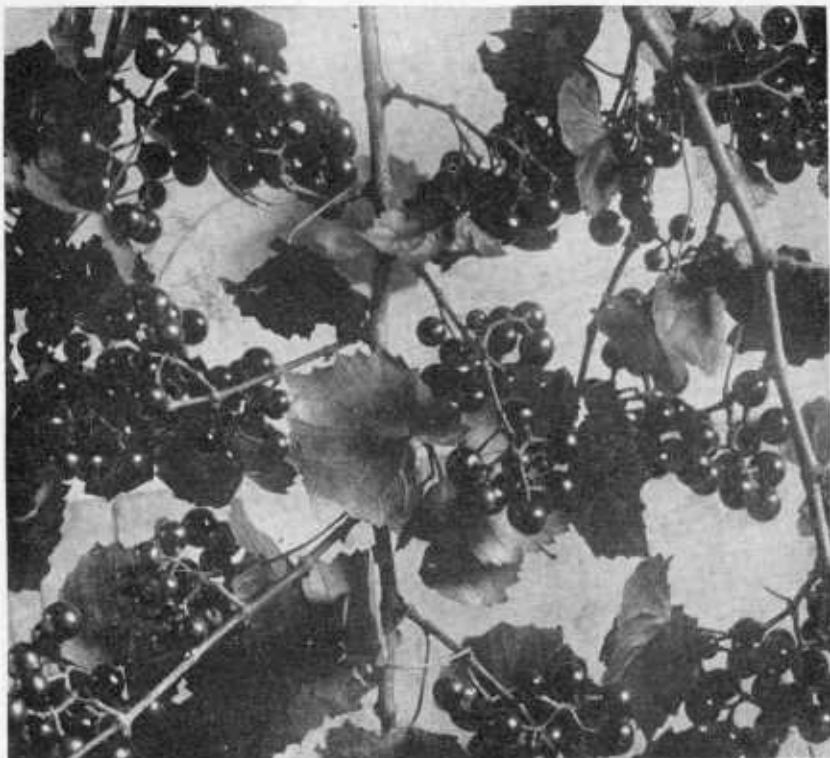


Figure 3.—Fruit and branches of *Vitis munsoniana* (about half natural size).

even large branches when permitted to do so. The leaves are below medium size, smooth and shiny on both sides, more or less round to broadly cordate with a wide, rather shallow basal sinus, and generally not lobed, though sometimes slightly three-lobed. The margins of the leaves are prominently toothed.

The fruit clusters are more or less roundish, ranging from loose to compact, and are relatively small, consisting of 1 to 40 berries, generally 4 to 10. The berries are round and range from very small to very large. They are green, pearly, bronze, red, or black and usually are more or less speckled with red or russet dots. The skin is relatively thick and tough, sometimes giving the impression of leatherness; the pulp varies from meaty to melting and juicy. The seeds (fig. 4), of which there are 2 to 4 and occasionally 1, 5, or 6, vary with the variety from small to very large. They are flattened, shallow, broad, notched, with very short, pointed beak and narrow raphe and chalaza, surrounded by radiating wrinkles. In all the older varieties the pollen is almost all abortive. The staminate, or male, vines have pollen-bearing stamens but abortive pistils. Planting of staminate vines for cross-pollination is essential. The muscadine vines are late in leafing out and flowering in the spring, and the fruit of most varieties is late in maturing.

PROPAGATION

Muscadine grapes may be propagated from seed or by cuttings, layers, or grafts.

SEEDS

Muscadine grapes should be grown from seed only when it is desired to produce new varieties, as in plant breeding. In common with most other fruits, these grapes do not come true from seed.

CUTTINGS

Although many methods of propagating muscadine grapes from cuttings have been tried, none has proved altogether satisfactory. Always fewer plants than desired are produced, because the very hard wood of muscadine grapes does not callus readily and does not put out roots freely. Better results have been obtained outdoors in northern Florida than in eastern North Carolina because the climate and soil conditions are more favorable for the production of roots. In field planting the best results have been obtained by using long cuttings (15 to 18 inches) of short-jointed, medium-sized, well-ripened wood cut in the early winter and stored in a callusing mound until about the first of April and then planted in a nursery row in well-prepared ground, with only one or two buds at the top left above ground.

Success in rooting cuttings is determined to some extent by moisture conditions; if the soil dries out, the cuttings do not thrive. It is also important to keep the nursery free from grass and other weeds. Considerable difference has been found to exist in the relative rooting qualities of different varieties. Some of the staminate muscadines root with relative ease. Of the commercial varieties, the Thomas and Flowers give the best results, the James and Eden are intermediate, and the Scuppernong roots with greatest difficulty. The Memory and Creswell varieties also root relatively easily. In the most successful tests with Scuppernong at Willard, N. C., only 4 percent rooted, whereas as many as 48 percent of the Thomas cuttings rooted outdoors.

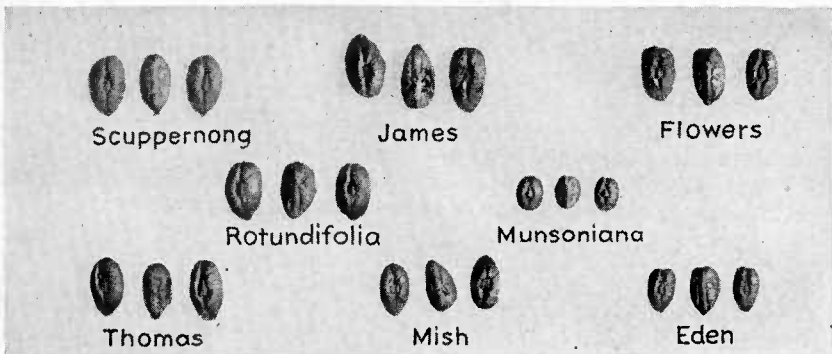


Figure 4.—Typical muscadine grape seeds, showing differences in size and type for different species and varieties. In each set the middle seed shows the reverse side.

One means of furthering the rooting of cuttings is to graft a small piece of young muscadine root on the basal end of the cutting and then treat such grafts as if they were cuttings. In this manner 86 percent of the Thomas and 20 percent of the Scuppernong cuttings were rooted in a normal season. Expert propagators with greenhouse facilities can root muscadine grape cuttings with relative ease on a greenhouse bench with bottom heat and regularly maintained proper moisture and soil temperature.

LAYERS

Layering is the method practiced most commonly by grape growers and nurserymen in propagating muscadine grapes. By this method the greatest number of plants are produced with the least expense. Canes can be layered at any season of the year, but midsummer is the most favorable time. For midsummer layering, canes of the same season's growth are bent down to the ground and covered with earth, the growing tips being allowed to project above the soil. Roots form by fall, and the layers can then be cut from the parent vine, giving at least one new plant for each shoot layered. If a large branch has been layered in the fall or spring, it generally develops shoots from a number of nodes or buds. Roots develop on each of these shoot bases; these can be cut apart during the dormant season and thus several plants are obtained from each long cane laid down. When such large branches or canes are used, they are pegged down in trenches in the spring but are not covered with soil until after shoot growth starts from the various buds. After shoot growth has started, soil is filled in over the mother cane and about the shoot bases, leaving all shoot tips exposed. The rooted layers are generally left undisturbed until the following winter, when they are taken up and planted in new locations.

When nurserymen grow muscadine especially for layering, the vines are not trellised but grow along the surface of the ground. In July or August the current-season shoots are covered with soil, leaving the tips exposed. Each shoot so covered will form roots and can be cut away from the parent plant during the following winter. In cutting away the rooted shoots, spurs are left which again form shoots suitable for layering the following season.

GRAFTS

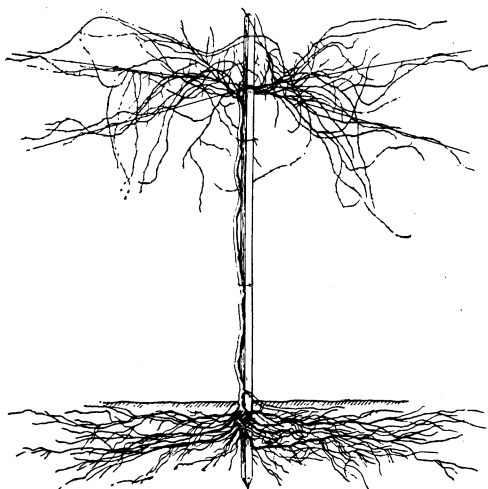
Muscadine grapes are seldom grafted, because the wood of the muscadine is very hard and the unions formed are usually poor. However, the grafting¹ of a cutting on a more readily rooting stock may assist a muscadine grape scion to put out its own roots.

SOILS

Muscadine grapes can be grown on almost any of the tillable soils of their natural habitat, but not with equal success; they do not thrive

¹ Methods of grafting are described in Farmers' Bulletin 471, Grape Propagation, Pruning, and Training. This bulletin is out of print, but may be consulted in libraries.

Figure 5.—A 4-year-old muscadine vine showing its characteristic shallow, spreading root system.



well in low, wet soil or on barren clay hills. The best results (fig. 5) with muscadine grapes, as with other fruits, are obtained on sandy loams that are well-drained and fairly fertile and contain a fair amount of organic matter. Muscadines also grow successfully in the better red-clay soils of the Piedmont province. Muscadine planting is not recommended where a hardpan is encountered near the surface.

Once established, muscadine vines grow in fairly wet ground, but not so well as on better drained land and the fruit is not of a good quality. Furthermore, it is difficult to get a stand of vines in such a soil unless the rows where the vines are to be planted are temporarily drained by plowing a furrow away from them on either side, leaving the rows as narrow strips not more than 2 feet wide. After the plants have become established, the furrows are closed.

If the vines are to be planted on new land, it is desirable to grow tobacco, corn, cotton, or some other annual crop requiring cultivation and in addition a leguminous crop, such as cowpeas, prior to setting out the grapevines. This procedure puts the ground in ideal condition for planting vines.

PLANTING

In North Carolina and throughout the Piedmont province the best time to plant is early spring, preferably March. Where the growing season starts earlier, planting in January or February is probably better. Either 1- or 2-year-old vines are suitable for planting, but strong 1-year-old plants are usually preferred.

Figure 6, *A*, shows muscadine grape plants as they are received from the nursery. These plants should be pruned before being planted, as shown in figure 6, *B*. The tops of the plants should be shortened to a single stem so as to leave one or two buds above ground.

The hole in which the plant is to be set should be made wide enough to prevent crowding the roots and deep enough to permit several shovelfuls of good surface soil to be thrown into the bottom. The vine, when placed in position, should be as deep as it was in the nursery row



Figure 6.—Muscadine vines: *A*, As received from the nursery; *B*, pruned and ready for planting. In both *A* and *B* the three plants on the left were grown from cuttings and those on the right from layers.

or slightly deeper. The hole should be entirely filled with surface soil worked in among the roots of the plant, and the whole mass of soil should be firmed as the hole is filled.

It is important that the roots of the vines be prevented from drying after arrival from the nursery and during planting. Excessive drying of roots by the sun and wind during planting or by dry storage prior to planting may result in serious loss. Often a wet burlap bag spread over the roots is all the protection that is needed.

The distance apart for planting muscadine grapes depends upon the variety and the training system used. The James, Flowers, and Mish varieties can be grown closer together than the more vigorous varieties like Thomas, Scuppernong, and Eden. If vines are grown on a vertical trellis, the rows should be at least 10 feet apart. Vines may be set 15 to 20 feet apart in the row. Other spacings are often used for specific conditions. For an overhead horizontal trellis, setting vines 15 by 15 feet apart will generally be right if the vines are pruned as recommended on pages 17 to 22.

SOIL MANAGEMENT

Two methods of handling muscadine vineyards have been widely used. One method, particularly where the overhead trellis is used and where small farm plantings are made, has been to maintain the vine-

yard in sod. Although yields are generally much lower and the quality of the fruit produced is poorer than that produced under cultivation, there are advantages in sod for the small-vineyard operator. Some fruit can be obtained with a minimum expenditure of labor. A vineyard in sod should be so managed as to keep grass and other weeds from depleting the soil of mineral nutrients and moisture. Such a vineyard will also be benefited by a mulch of organic matter, such as straw, corn fodder, peanut vines, or similar material, piled several inches deep for a distance of several feet around each vine.

A light disking or other cultivation once a year, or even once every 2 or 3 years, incorporates organic matter into the soil, releases soil nitrates, and may prove beneficial in stimulating the growth of plants. The use of fertilizer high in nitrogen is also essential for good growth of vines in sod. The sod-culture method is less satisfactory with the vertical trellis than with the overhead, because of the difficulty in keeping weeds and grass from the vines on the vertical trellis.

The other, and generally more desirable, method, followed in the larger commercial vineyards, has consisted in systematic cultivation and growing of soil-improvement cover crops between the vines (fig. 7). Under this method the maximum yields can be obtained.

With either system of handling, the soil should be well prepared before the grapevines are planted. Under intensive culture companion crops to carry a part of the expense of maintaining the vineyard, as well as soil-improvement crops, can be grown. For cash intercrops during the first years of the vineyard, cultivated kinds such as melons, tomatoes, peanuts, cotton, or tobacco are very satisfactory (fig. 8). Corn and grain appear less desirable than crops of the type listed.

In most of the muscadine region, after a cash crop of the type listed has been harvested, it is possible to seed an overwintering legume soil-improvement crop, such as Austrian Winter peas, vetch, or similar crops that have proved satisfactory in a particular district. These should be plowed or disked into the soil about the time they reach the blossoming stage, after which cultivated cash crops can again be planted for growth during the summer. Such a method of handling



Figure 7.—Muscadine vines with a mixed cover crop of cowpeas and grass growing between the rows.



Figure 8.—Muscadine vines grown with an intercrop.

will provide the maximum cash return during the early years of the vineyard and still maintain satisfactory growing conditions for the vines.

In a mature vineyard, especially with the overhead-type trellis, such cash crops as soybeans for seed, sweetpotatoes, and strawberries can be grown to help carry the annual maintenance cost. Some may prefer, however, to grow only soil-improving crops in mature vineyards.

FERTILIZATION

In order to obtain the best results with muscadine grapes, commercial fertilizers are usually required in addition to good culture, intercropping, and other devices for regulating crops, such as pruning and training. Young vines, especially during the first year after planting, require principally nitrogenous fertilizers, such as nitrate of soda, sulfate of ammonia, dried blood, tankage, guano, or cottonseed meal. Cottonseed meal, when not too expensive, is one of the best nitrogenous fertilizers for vineyards, because the nitrogen becomes available over a long period. It is good practice to mulch young vines with manure or, if it is not available, to side-dress the vines during April to June with nitrate of soda. The object of giving young vines heavy applications of fertilizer is to induce a robust growth, so that they will be capable of bearing profitable crops the third year. Under ordinary conditions such results will not be obtained earlier than the fourth year. Applications should be at the rate of about $\frac{1}{10}$ pound of actual nitrogen the first year, $\frac{1}{5}$ pound the second year, and $\frac{1}{3}$ pound the third year. Thus, a material such as nitrate of soda, containing 16 percent of actual nitrogen, would be applied at the rate of about $\frac{1}{2}$ pound, 1 pound, and 2 pounds per vine for the first, second, and third years, respectively.

Little experimental work has been done to determine the fertilizer response of bearing vines. Throughout the Southeastern States soils generally are deficient in potash, phosphorus, and nitrogen. In the

absence of specific information as to the response of muscadines to various kinds and mixtures of fertilizer, a mixed fertilizer fairly high in nitrogen is probably best. At the experimental vineyard maintained at Willard, N. C., by the Bureau of Plant Industry, Soils, and Agricultural Engineering and the North Carolina Agricultural Experiment Station, applications of 600 pounds per acre of a fertilizer analyzing 4 percent of nitrogen, 8 percent of phosphoric acid, and 4 percent of potash have given good results. In years of heavy crops or when vine vigor is low, about midsummer a supplemental application of about 400 pounds per acre of fertilizer of the same 4-8-4 formula would be advisable.

Barnyard manure applied prior to the spring cultivation or as a mulch on noncultivated vines will give excellent results. If the vines are not making as much growth as desired, increasing the nitrogen in the fertilizer should be beneficial. On the other hand, if the vines are overvegetative, reducing the nitrogen fertilizer will reduce growth. Once the vines are bearing, the fertilizer treatment may well be varied to fit the growth condition.

POLLINATION

The varieties of muscadine grapes ordinarily grown are practically self-sterile, even though the blossoms have both pistils and recurved stamens. In order to produce satisfactory crops they must be cross-pollinated with the fertile pollen of staminate muscadine vines. The staminate, or male, flowers have long, upright stamens which bear fertile pollen and rudimentary pistils, whereas the pistillate, or female, flowers have perfectly developed pistils and short recurved stamens containing abortive pollen. Although occasional fertile pollen grains may occur in the female flowers, they are essentially sterile and require pollination with pollen from the staminate vines. The staminate vines, of course, produce no fruit.

The pollen is carried from the male to the female flowers almost entirely by insects, particularly by several different kinds of small bees. The small mining bee (*Lasioglossum (Chloralictus) stultum* (Cress.)) is the most proficient in this task, while the honeybees are not of much assistance (fig. 9). In the past, in the ordinary small vineyard there have frequently been a sufficient number of wild male vines nearby to furnish adequate pollen for proper cross-pollination. However, it is essential to fruit production that the male vines be within 25 feet of the female ones, and if there are no wild male vines growing near the vineyard some should be included in every planting. The use of 1 male vine to every 8 fruiting vines has given good results. A suggested method is to plant a male or a perfect-flowered vine in every third position in every third row (fig. 10), starting at the second vine in the second row of the vineyard. It is important to use only vigorous, heavy-blooming male vines that bloom simultaneously with the fruiting vines to be pollinated.

As a result of the breeding work of the Bureau of Plant Industry, Soils, and Agricultural Engineering a perfect-flowered type of muscadine grape has been produced (figs. 11 and 12). Such perfect-flowered

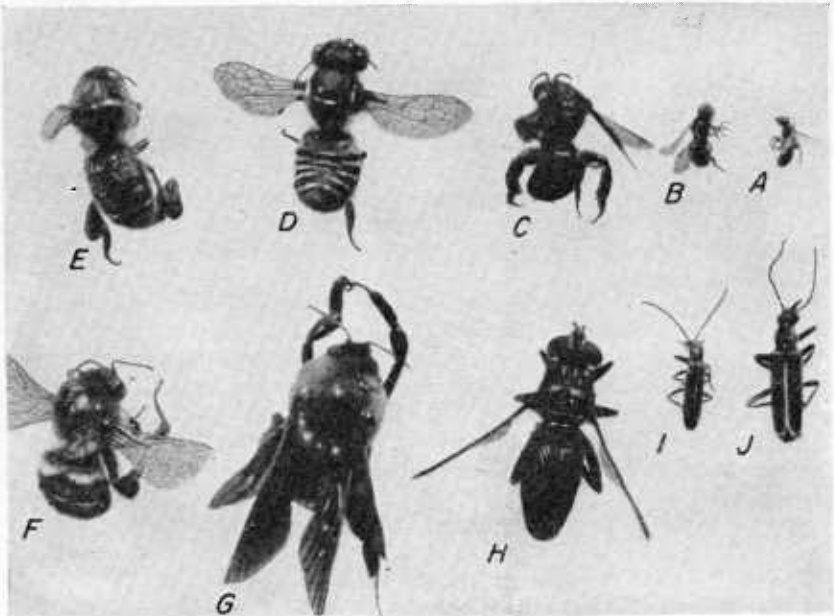


Figure 9.—Types of insects of value in pollinating muscadine grapes, in order of apparent value: A, Small mining bee (*Lasioglossum (Chloralictus) stultum*); B, large mining bee (*Halictus* sp.); C, green bee (*Agapostemon splendens* (Lep.)); D, gray bee (*Megachile* sp.); E, honeybee (*Apis mellifera* L.); F, small bumblebee (*Bombus impatiens* Cress.); G, large bumblebee (*B. fraternus* Smith); H, ornate flower fly (*Milesia virginiensis* (Drury)); I, beetle (*Copidita thoracica* (F.)); J, beetle (*Chauliognathus marginatus* (F.)).

kinds do not require cross-pollination in order to set fruit; when substituted for the unfruitful male vines they will increase the total production of the vineyard about 11 percent.

TRAINING AND PRUNING

TRAINING

Training refers to the method of distributing the growth of the vine on the support. Two general types are employed for muscadine grapes: (1) The upright, or vertical, system, in which the growth is spread over a vertical trellis (figs. 13 and 14); (2) the overhead, or horizontal, system, in which the growth is spread as an overhead canopy about 7 feet above ground (fig. 15). The upright trellis costs less to erect and is cheaper to repair. Weak-growing varieties are not so often allowed to overbear on a vertical trellis as on an overhead one. The overhead system allows cross-cultivation and easy access throughout the vineyard. An arbor of this type is often desirable for a few vines at the edge of the yard or garden.

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Figure 10.—A diagram showing one method of planting muscadine vines to obtain satisfactory pollination when vertical trellises are used. O, Fruitful vine; M, male or perfect-flowered vine.

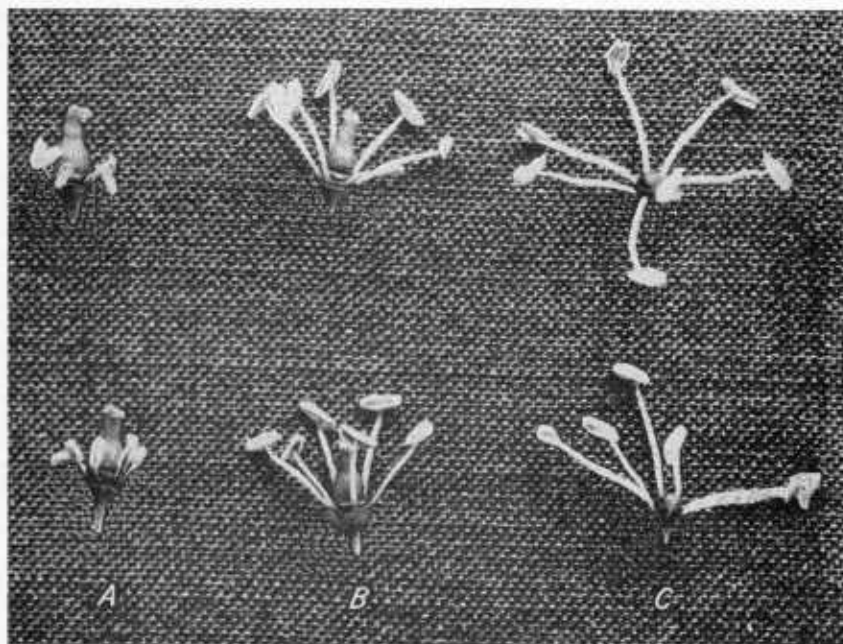


Figure 11.—Blossom types of muscadine grapes: A, Self-sterile pistillate blossoms; B, perfect blossoms, as found on self-fertile muscadine grapes; C, staminate blossoms.

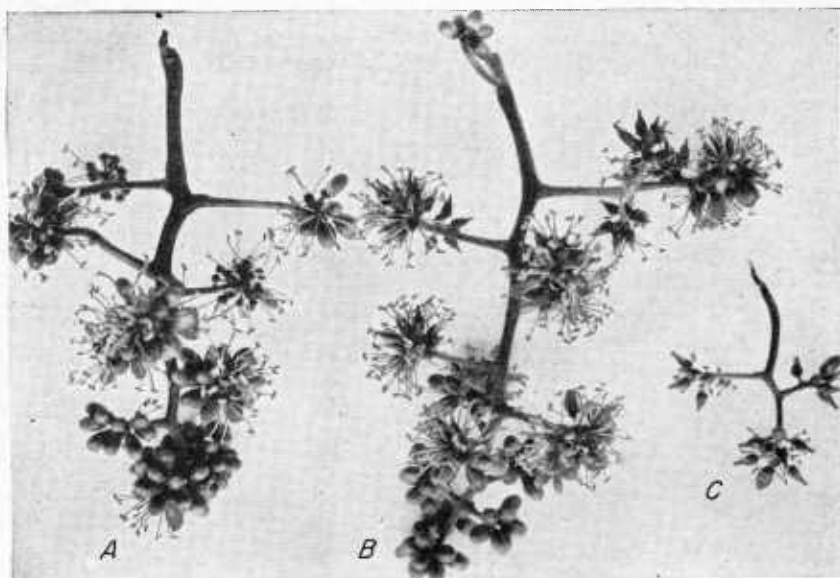


Figure 12.—Blossom-cluster types of muscadine grapes: *A*, Staminate cluster; *B*, self-fertile cluster; *C*, self-sterile pistillate cluster.

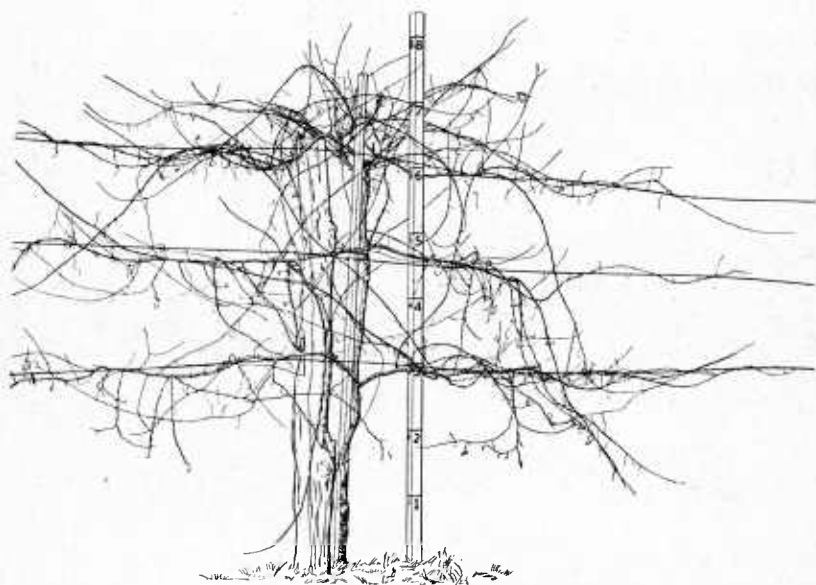


Figure 13.—An unpruned muscadine vine trained in accordance with the six-arm renewal system on a vertical trellis.

In the upright system either the fruiting arms are horizontal branches from a central trunk (fig. 13) or they may radiate from a low head, like the ribs of a fan (fig. 14). With the upright system of training, picking may be difficult. A three-wire trellis is used for the fan system, and a one-, two-, or three-wire trellis for the horizontal-arm system. Shorter posts can be used for the two-wire trellis than for the three-wire ones; these are less expensive and less easily broken. Also, the training, pruning, and harvesting are facilitated on the two-wire trellis, for the vines are within easy reach.

During the first 3 years the permanent parts of the vines are established, and this requires some pruning. During the first season one stem should be trained to a stake and kept disbudded. Under satisfactory conditions a large proportion of the vines should develop to the height of the top wire by the end of the first year. During the first winter after this stem reaches the highest wire of the trellis it should be topped, to promote branching. This stem, which will then form the permanent trunk of the vine, should be kept straight by tying it taut to the wire. If the stem is not long enough to reach the first wire of the vertical trellis, it should be cut back to a stub of about three buds and the next year it should be handled as a newly set vine. Strong laterals arising at each wire or just below are then trained along the wires to form the arms. Strong laterals radiating upward from around the lowest wire form the arms of the fan system.

In the overhead system the vines are trained to a single trunk about 7 feet in length, and the arms radiate from the top of this trunk as do

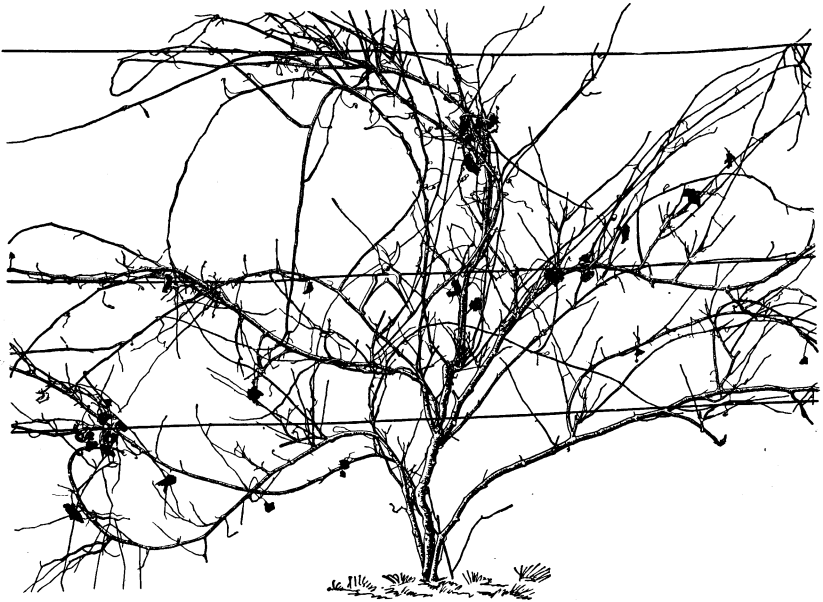


Figure 14.—An unpruned muscadine vine trained in accordance with the radiating, or fan, system on a vertical trellis.

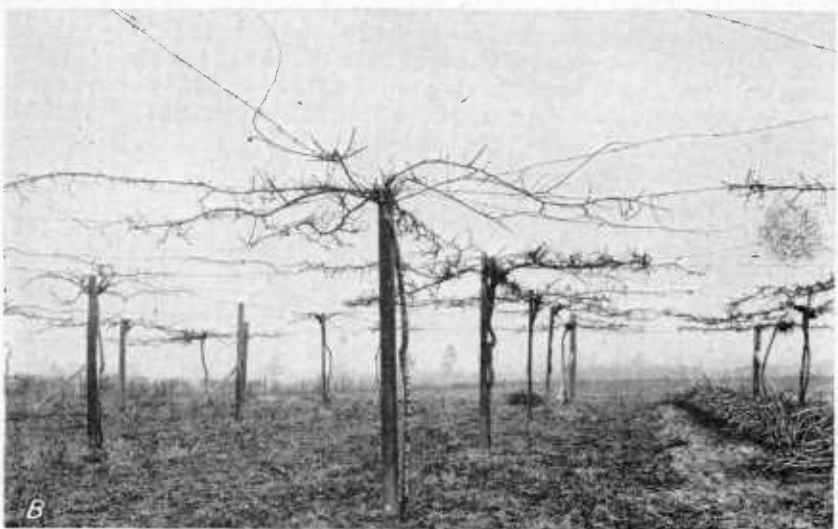
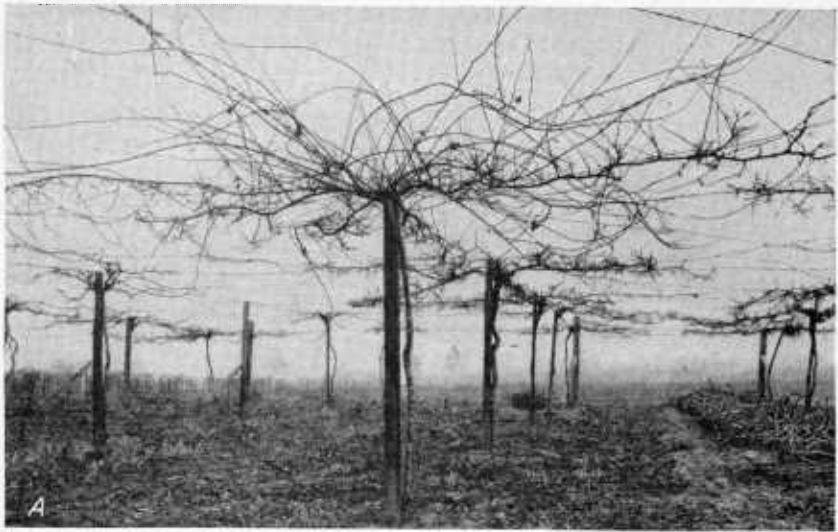


Figure 15.—Type of overhead trellis recommended in this bulletin: *A*, An unpruned vine in the foreground; *B*, the same vine after it was pruned. The brush removed from the other vines can be seen here and there on the ground, especially at the right. (Photographs by courtesy of J. Horace McFarland Co., publishers, Harrisburg, Pa.)

the spokes from the hub of a horizontal wheel (fig. 15). Eight fruiting arms per vine can be maintained, and these should be established by the time the vine is 5 or 6 years old. When the vineyard is not given close attention and pruning and when culture, fertilizing, and other care cannot be given, the best results will certainly be obtained with the overhead trellis.

TRELLIS CONSTRUCTION

During the first year after planting, a strong stake firmly placed and reaching 7 feet above ground may be sufficient support for a slowly growing young vine. For a very vigorous young vine a trellis should be provided the first year, but the secondary wires of an overhead trellis can be added later as the vines need them.

In erecting a vertical trellis the posts should be set midway between the vines, the distance apart varying with the distance between the plants. With either the two- or three-wire trellis, the lower wire should be not less than 2 feet from the ground and there should be at least 2 feet between the wires; more distance is preferred.

There are various styles of overhead trellis, but it is most satisfactory to set a substantial, durable post reaching 7 feet above ground at each vine. Rows of extra-heavy posts running parallel with the rows of vines and also at their ends are set at the boundaries of the vineyard $7\frac{1}{2}$ feet outside the vine posts. The four outside corner posts should be even heavier than the other outside boundary posts; No. 10 galvanized wire is first run around the outside posts and securely fastened to each. The No. 10 wires are then run along all the vine posts in each row from north to south and from east to west, being stapled to each post. These primary wires are all that will be needed for the first and second years. After the pruning at the end of the second season another No. 10 wire is run diagonally from northeast to southwest and a year later the last wire is run diagonally from northwest to southeast; if preferred, both diagonal wires can be established at the same time after the second growing season. These four wires, which are made to cross at each vine post 7 feet above ground, provide support for eight fruiting arms radiating from the vine head at the top of the post. Some growers construct arbors entirely of wood, using slats and poles in lieu of wire, but such arbors are less durable and are unsatisfactory for commercial vineyards. They are mostly used for individual vines or small arbor plantings.

PRUNING

Pruning refers to the method of renewing and controlling growth by cutting away portions of the vine. Its purpose is to regulate and maintain the balance between fruit and wood production. Fruit is produced on the current season's growth, which comes primarily from buds on the previous year's growth. Old wood does not produce fruit, but when pruned it produces the new growth which is fruitful. Under a program of systematic pruning, production is much more regular than on unpruned vines. The fruit is larger, ripens better, and is of much better quality.

During the first 3 years pruning is based primarily on establishing the permanent parts of a specific training system. Laterals that develop along this trunk should be pruned off during the dormant season, and any additional canes that start growth from the base of the vine should be removed. After this training of the trunk and arms, pruning consists of spurring, or stubbing back, the new growth along the arms to 4 to 6 inches to leave three or four buds. During the next

growing season from these buds new shoots, each carrying one to four clusters of grapes, will arise. This process of pruning back the new growth to spurs should be followed each year. For several years fruiting capacity increases with the age of the arms, but ultimately their growth and vigor decline and the yields decrease. When this condition is reached, the arms should be renewed. This is done by cutting the old arm back to a strong shoot near the base or by taking a strong shoot from the trunk and training it along the wire as was done in establishing the original arms. Since the new canes without spurs produce only half to a third as much as the established arms, only one or two arms should be renewed at a time to avoid a reduction in yield during any one year.

Severe pruning tends to make the vines more vegetative; light pruning tends to give heavy crops and limited vegetative growth. Pruning and other cultural practices must therefore be adjusted to provide a balanced production and growth condition each season. If a vine is overvegetative, the spurs should be left a little longer and with more buds at pruning time. On the other hand, if the growth of the vine is too weak it may have overfruited; in that case the pruning during the following winter should be heavier, and fewer buds should be left for fruiting during the next year. Such pruning can be done by shortening the spurs and by renewing some of the arms.

Muscadine vines may be pruned at any time when the foliage is off. If pruning is done immediately after leaf fall there is little or no loss of sap, or bleeding, but the amount of bleeding increases shortly thereafter and months before growth starts. This frequently alarms the grower, but the loss is almost entirely water. In experimental tests pruning on March 1, when severe bleeding occurred, resulted in as good yields as pruning on December 1, when no bleeding occurred. It is desirable to complete the work before the buds swell in the spring.

Figure 6, *B*, shows the manner of pruning muscadines when planted. At the ends of the first and second vineyard years when trained to the horizontal, or overhead, system the vines should look like those in figure 16. Figure 17 shows how the vines trained to the vertical radiating system should look after being pruned at the end of the first, second, and fourth vineyard years. Similar vines when trained to the vertical six-arm system should look like those in figure 18. Figure 13 shows an older unpruned vine on a vertical system, figure 14 a similar vine on a radiating, or fan, system, and figure 15 a similar vine before and after pruning on an overhead system. A careful study of these illustrations will give a general idea as to pruning procedure from year to year, particularly for a young vineyard.

PRACTICAL TRAINING AND PRUNING FOR COMMERCIAL PLANTINGS

In the foregoing discussion of training, trellises, and pruning both overhead and upright training systems were considered. In its experimental vineyard at the North Carolina Coastal Plain Branch Station, the Bureau of Plant Industry, Soils, and Agricultural Engineering has tried practically all systems and has come to prefer the overhead eight-arm system of training and pruning for commercial plantings. This system provides for the free use of the land between

vines for intercropping, affords uniform exposure and vigor of all fruiting arms, and permits more bearing surface per vine and consequently provides opportunity for larger yields per acre. It also enables easy harvest by either hand-picking or shattering of the fruit onto sheets. This system of training is described fully.

The plants are set on the north side of each vine post and trained on that side to reduce exposure to winter sun. As the vine reaches the top of the post it is cut off to promote branching. In the second growing season four shoots are trained from the top of the vine along the four primary wires of the trellis radiating from the top of the post and all other growths are rubbed off. At the end of the second season pruning consists of spurring any lateral growths on these four arms. This stimulates lateral growth and the forming of more arms at the vine head. In the third growing season a fifth arm is trained on one of the diagonal wires, and each year thereafter another diagonal-wire arm is developed until the vine has eight arms. After that, eight arms are

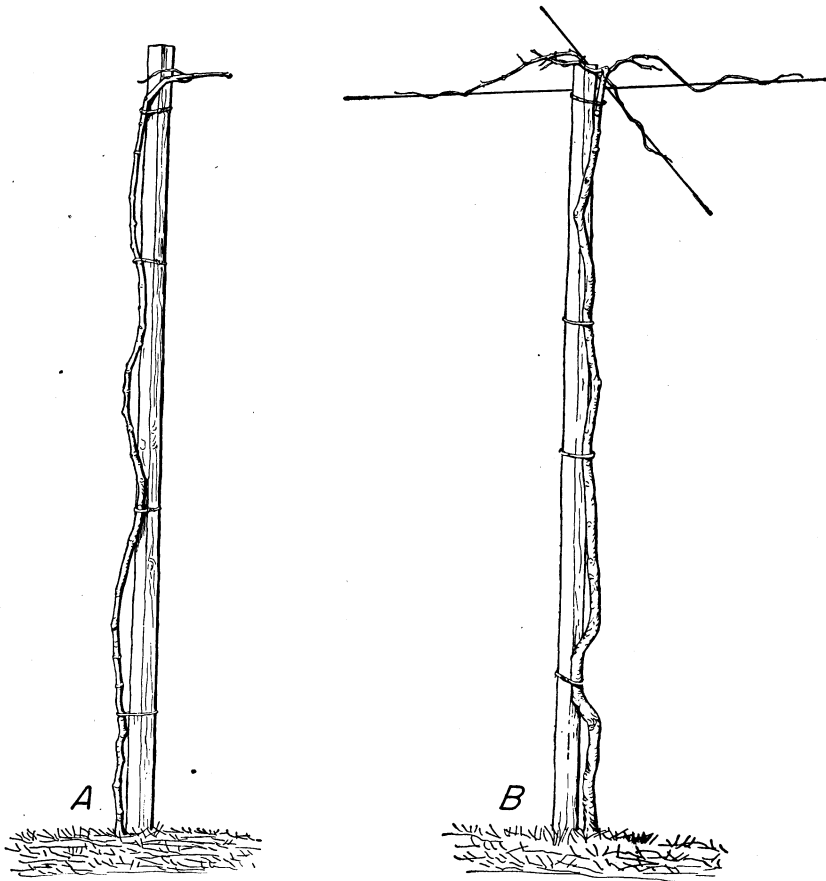


Figure 16.—Muscadine vines trained in accordance with the horizontal, or overhead, system: A, End of first vineyard year; B, end of second year.

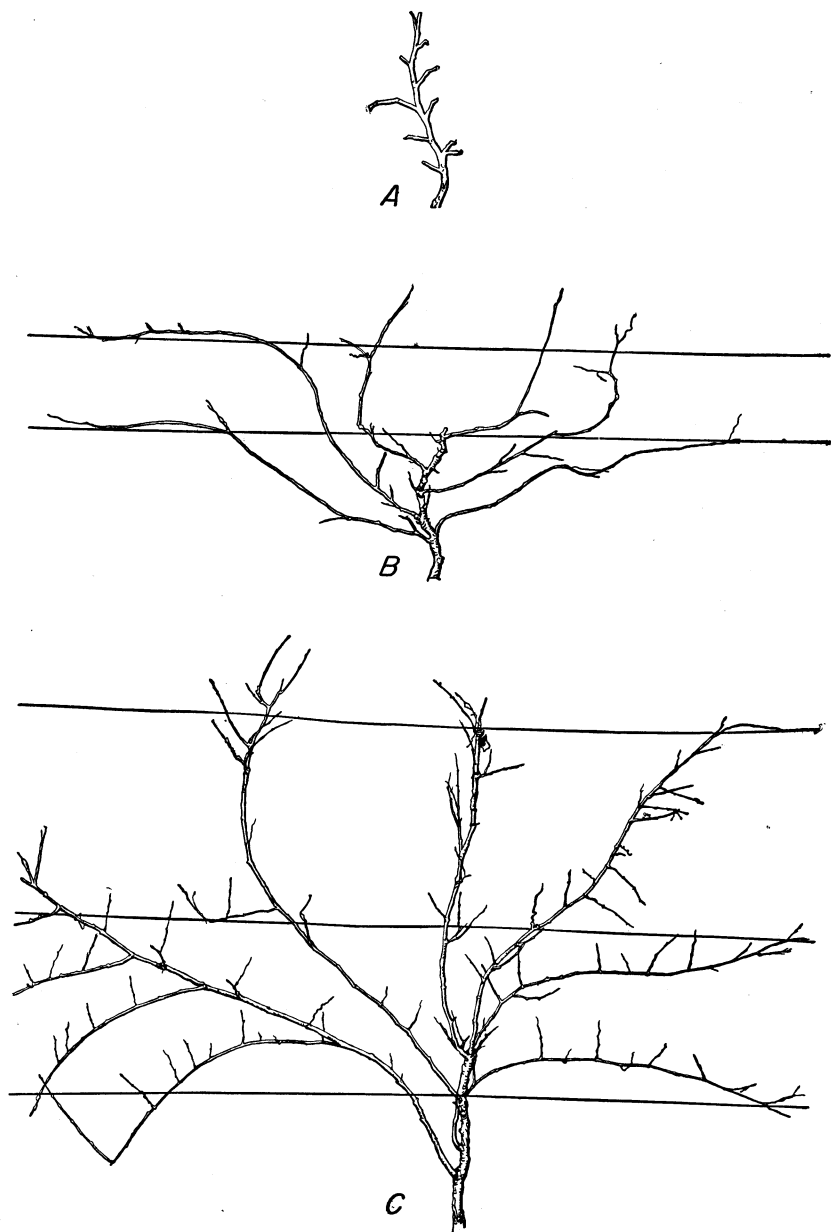


Figure 17.—Muscadine vines trained in accordance with the vertical, radiating system: *A*, End of first vineyard year; *B*, end of second year; *C*, end of fourth year.

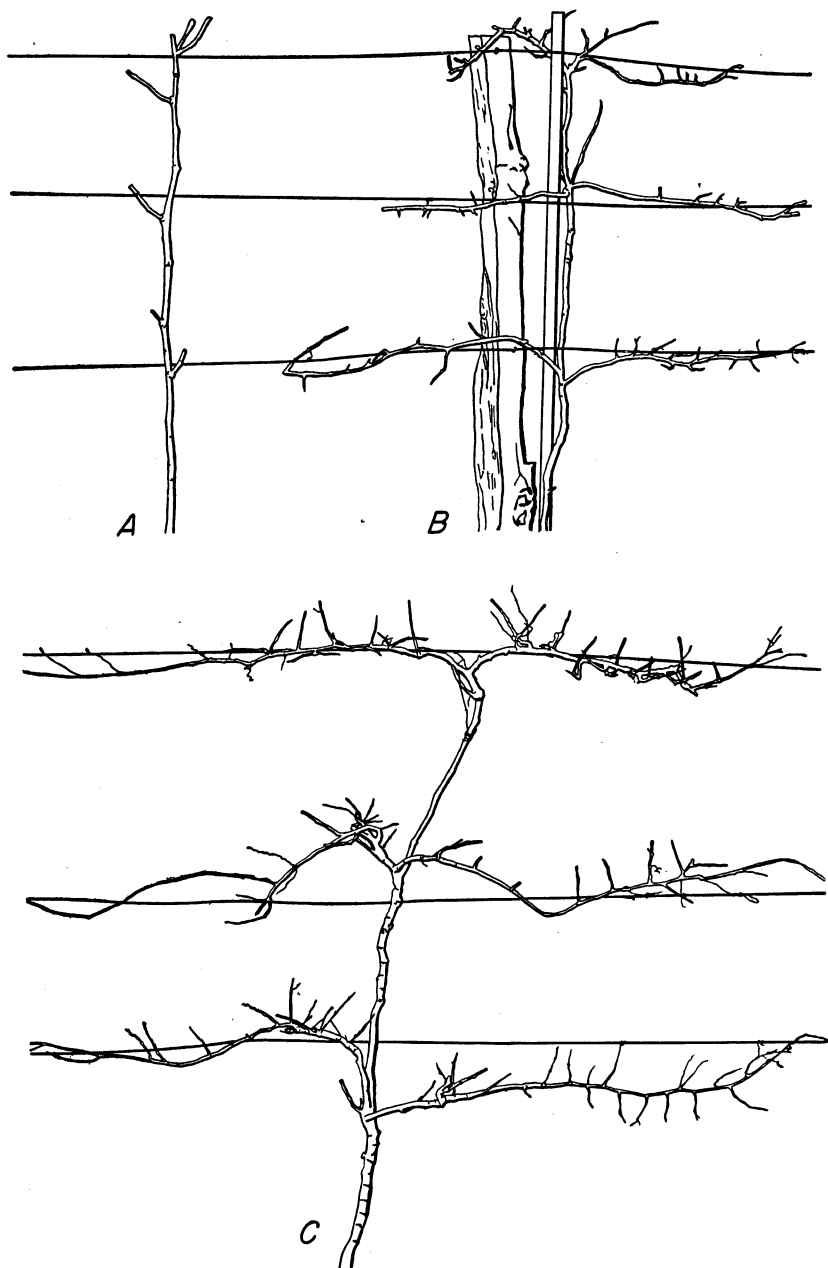


Figure 18.—Muscadine vines trained in accordance with the vertical six-arm renewal system: *A*, End of first vineyard year; *B*, end of second year; *C*, end of fourth year.

maintained; each year one fruiting arm, the oldest, is replaced by a young cane. This succession, or renewal, of arms is started at the end of the third growing season by cutting away and renewing one of the four arms first developed during the second growing season. Each year the lateral growths on the arms not renewed are spurred. As arms develop they gradually elongate along the wires until they meet arms of adjoining vines, but they are never allowed to overlap. The arms are fastened to the wires by wrapping them around once or twice and tying them to the wire at the outer end. The tendrils also help to fasten the vine to the wire. Vigorous vines develop more rapidly and slow-growing or poorly tended vines develop less rapidly. Such pruning and training can be done by farm labor of average intelligence if the system is explained and demonstrated from year to year.

HARVESTING AND HANDLING

Muscadine varieties differ in the manner in which the berries adhere to the cluster as they ripen. The berries of some varieties hang tightly until fully mature but may be torn in picking; those of other varieties tend to shell from the cluster, and many drop before harvest. Of the varieties whose berries tend to drop prematurely, some have berries that have a dry scar on shelling and others a moist scar, which favors spoilage.

The usual practice in harvesting these grapes for juice is to jar them from the vines onto canvas or burlap sheets spread or carried under the vines. The leaves, twigs, and other debris accumulated with the fruit are separated from it either by hand-picking and rolling the fruit back and forth on the cloths or by running the fruit through a fanning mill or some other blowing apparatus. Formerly, after being cleaned the jarred grapes were put in barrels and hauled or shipped to the winery or used locally; now, the large wineries establish receiving depots in various towns and cities, where the growers can procure bushel baskets or lug boxes in which to place the grapes. They are then brought to the depot and weighed in. Sixty pounds is considered a bushel, and the grower is given a check on the basis of the weight of the fruit brought in. The receiver then loads this fruit onto trucks and hauls it to centralized wineries. In this way large plants draw their supply of grapes from a wide territory surrounding the plant.

The skin of most muscadine varieties is sufficiently tough to stand jarring from the vines and cleaning without excessive injury to the fruit, provided all operations are done carefully and the fruit is delivered to the buyer promptly. Some bruising and injury inevitably occur; and if the fruit is not sent promptly to the winery and put through the crusher, excessive decay is likely to develop. If the fruit is rapidly and carefully handled, however, it can be delivered to wineries in a satisfactory condition.

When fruit must stay in good condition for several days after harvest, hand-picking is essential; therefore, all fruit for table use or shipping should be hand-picked. The varieties that do not shatter from the stem readily are best for shipping. Such grapes should be carefully and attractively packed (fig. 19).

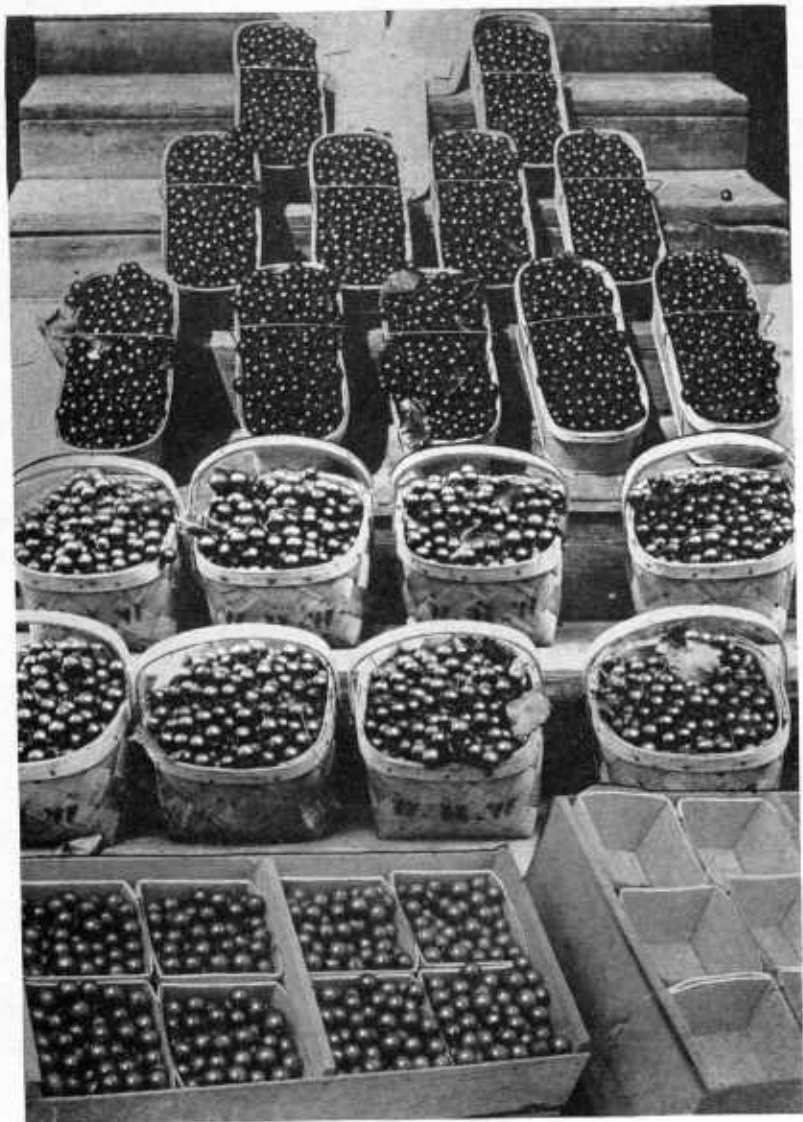


Figure 19.—Hand-picked muscadine grapes ready for shipment.

YIELDS AND VALUE

The Scuppernong—the variety that has been in greatest demand—yields relatively small crops as compared with the James, the Thomas, and other prolific sorts. An average yield of 25 to 30 bushels of grapes per acre from 4-year-old vines, 50 to 75 bushels from 5-year-old vines, and 100 to 150 bushels from vines in full bearing should be obtained from vineyards receiving good care.

Great variations in the yields occur, however. Inferior crops may be caused by wet, cool weather at blooming time, late frosts, black rot injury to bloom and foliage, weak, old vines, lack of pruning, or lack of fertilization. Although yields of 150 to 200 bushels per acre are occasionally reliably reported, over a period of years an average yield of 75 bushels of Scuppernong and 100 to 125 bushels of the more prolific varieties would be considered satisfactory. Generally the light-colored varieties sought by the wineries have sold for higher prices on the general market than the dark-colored ones. A limited quantity of choice, hand-picked fruit in half-bushel baskets, tubs, berry crates, or grape baskets usually sells at prices approximately double those paid for shattered wine grapes.

USES

Muscadine grapes are used principally for wine making. This wine is made by vineyardists and sold at retail or is made and sold by large companies. The wine made from Scuppernong and other muscadine varieties has a characteristic flavor and quality and has always been in demand.

An unfermented juice can be made for home and market. The Thomas variety is especially adapted for this purpose, and the juice is highly prized as a summer fruit drink in the South. The more acid muscadines require the addition of sugar to make a satisfactory juice.

As fresh fruit, muscadines are relished, especially if they are eaten soon after they are picked. It is a social custom in the South to visit under the arbors and eat the grapes from the vines. After picking, the grapes deteriorate rapidly in both flavor and aroma, regardless of storage conditions, and for this reason they should be used soon after harvest.

As most of the varieties shell from the cluster when harvested and fermentation soon starts, they are not generally adapted for shipping; however, certain varieties can be shipped successfully. Their shipment as a fresh fruit, however, is a relatively undeveloped phase of the industry. All muscadine grapes make excellent jellies, preserves, catsup, and other culinary products; certain varieties are particularly adapted to each of these products. The canned grapes are used for pies.²

INSECT ENEMIES AND DISEASES ³

Muscadine grapes usually are not seriously affected by insect enemies and diseases. However, insects and diseases are found on them which, although not serious at present, should be noted and observed. The most important disease is black rot, caused by *Guignardia bid-*

² For further information on the utilization of muscadine grapes see Farmers' Bulletin 1075, Unfermented Grape Juice, and Farmers' Bulletin 1454, Home Utilization of Muscadine Grapes. The former is out of print, but it may be consulted in libraries.

³ See also Farmers' Bulletin 1893, Control of Grape Diseases and Insects in Eastern United States.

wellii (Ell.) Viala and Ravaz, which generally attacks other grape species. This disease does not affect the fruit of muscadines as seriously as it does that of bunch varieties, but it blights the bloom buds in unfavorable growing seasons. It sometimes affects the foliage of muscadines just as it does that of bunch varieties by causing brick-red diseased areas in which spore cases resembling tiny black dots may be noted. The most satisfactory remedy now known for this disease is to spray with bordeaux mixture. Directions for spraying may be obtained from the United States Department of Agriculture, Washington 25, D. C., State agricultural colleges, or county agricultural agents.

VARIETIES

It is not possible to give detailed descriptions of varieties in a bulletin of restricted size; therefore, only general descriptions of the leading varieties will be given.⁴

Muscadines of a particular color erroneously have often been considered as belonging to a single variety. Color is determined by the amount of colored pigment present in the skin. If there is none of this pigment present, the berry is said to be "white," bronze, or green. Small quantities of the pigment give a berry a slightly pinkish color; with more pigment present the berry is decidedly pink; with still more it becomes red, purplish red, black, and finally jet black. In the collection of varieties at Willard, N. C., every gradation in color has been found. It is better, therefore, to know the varieties by names rather than to attempt to distinguish them by color or to group them in color groups.

The muscadine varieties fall into two general groups: (1) Older varieties which have been selected as superior native seedlings and brought under culture by transplanting and propagation and (2) newer varieties which are the result of plant-breeding work of the United States Department of Agriculture, the State experiment stations, and individual breeders. On the basis of acreage under culture and planted about the homes of the Southeast on arbors for home use, the older native selections are still the more important group; but as plant breeding goes forward and new productions are tested most of the older group at least will lose their popularity. In this bulletin those of the older native group are listed first and placed in the order of acreage under culture at the present.

SCUPPERNONG

The Scuppernong is probably the oldest cultivated variety of native American grapes. Although the place of origin cannot be stated positively because of the age of the variety, it has been rather definitely established as being in Tyrrell County, N. C., before 1760. From there it was soon distributed over northeastern North Carolina and to Roanoke Island. In this section are many large old Scuppernong vines, some of which are known to be over 125 years of age. An

⁴Those desiring detailed descriptions are referred to U. S. Bur. Plant Indus. Bul. 273, The Muscadine Grapes. Out of print, but may be consulted in libraries.

old vine growing on Roanoke Island is said to have been planted by Sir Walter Raleigh and to be the original Scuppernong. Those who have investigated most closely the origin of the variety, however, adhere to the theory that the original vine grew wild in Tyrrell County, in the vicinity of the Scuppernong River.

Throughout eastern North Carolina the Scuppernong variety was planted in vineyards ranging in size from a few vines to many acres. Some of these vineyards have been steadily enlarged, but many were allowed to deteriorate. From these vineyards the variety was gradually distributed over the Coastal Plain and Piedmont sections of the Southeastern States. It has steadily increased in popularity and is today the leading variety.

The vine is productive, and the growth is vigorous; it has long, slender, smooth, yellowish canes covered with small light-brown dots or lenticels. It thrives best in well-drained sandy loams. The leaves are medium-sized and cordate and have medium-serrate margins. In texture the leaf is smooth and rather thin in comparison with leaves of other varieties. The fruit ripens fairly early. The cluster is small, having 1 to 15 berries (generally 2 to 6). The individual berries shatter readily from the cluster when ripe. They average $\frac{3}{4}$ of an inch in diameter and when fully ripe vary from pearly green to reddish brown, depending on the amount of exposure to the sun. The skin is medium tough and covered with numerous small russet dots and sometimes with russet blotches. The flesh is pale green, juicy, soft, musky, sweet, sprightly, and of good quality. The seeds are large. The Scuppernong is suitable for home use and wine making. It yields well but is not so productive as the James or the Thomas.

THOMAS

The Thomas grape was discovered between 1850 and 1855 by Drewery Thomas near Marion, S. C., growing in a fine sandy loam with fine clay subsoil. The vine is very productive, and the growth is vigorous and rank. The leaves are broadly cordate and rather thick and have serrate margins. The fruit ripens in early midseason. The cluster is round. The berries ripen unevenly and adhere poorly to the stem. They are medium-sized, round, and dark-wine-colored when fully ripe. Surrounding the base of each berry is a wide, prominent, irregular, greenish-yellow, pentagonal marking. The skin is thin and moderately tough, with numerous pimples dotting the surface. The flesh is tender, juicy, and very sweet and has an exceptionally rich, fruity, sprightly flavor. The Thomas is the best standard variety for unfermented juice and preserve making. In fact it is perhaps the best all-round variety, because it is versatile and reliable.

JAMES

The James variety was discovered about 1866 by B. W. M. James in Pitt County, N. C. It thrives in fine sandy loams with clay subsoil. The vine is very productive and vigorous, and the growth is slightly trailing. The leaves are cordate, nearly as broad as long, and medium-sized and have serrate margins; in late summer they have a mottled

yellow and green appearance. The fruit is rather late in ripening. The cluster is round. The berries are very large, rather glossy, and bluish or deep-purplish black when fully ripe; they have pronounced, not very numerous "guinea-egg" specks. When the berries are not fully ripe, they have a characteristic reddish coloring around the stem. The skin is thick and rather tough. The flesh is juicy, meaty, and of medium flavor and quality. The James is an all-purpose grape, being good for dessert, market, wine, or culinary uses.

MISH

The Mish variety was discovered by Albert Mish between 1840 and 1850, growing in pure river sand near Washington, N. C. The vine is very productive, and the growth is vigorous, rather open, and slightly trailing. The leaves are rather round, thick, and above medium size. The fruit ripens moderately late but uniformly. The cluster is medium-sized. The berries adhere fairly well to the stem. They range from about $1\frac{1}{16}$ to $\frac{3}{4}$ of an inch in diameter, are slightly ovoid and almost black, and have numerous "guinea-egg" specks. The skin is medium thin and cracks in wet weather. The flesh is tender, juicy, and sweet; the flavor is distinct, delicious, and fine. The Mish is a fine all-round variety, and next to the Scuppernong it is most highly esteemed as a wine grape.

FLOWERS

The Flowers grape was discovered by "Popping Billy" Flowers in 1819, growing in a sandy loam in Robeson County, N. C. It thrives in northern Florida and is said to do well as far south as the Florida Keys. The vine is very productive, and the growth is upright, rather open, and moderate. The leaves vary, but they are usually medium-sized, longer than broad, pointed, cordate, thick, dark green, slick, and leathery and have sharply serrate margins. The fruit ripens late. The cluster is round, generally containing 6 to 10 medium-sized, purplish-black, slightly oval berries. The skin is very thick, tough, and faintly marked with dots. The flesh is white, meaty, tough, and not very juicy; the flavor is sweetish, lacks sprightliness, and is of medium quality. The variety makes good wine. Although the skins are thick they cook very tender. The variety is accordingly good for certain culinary uses, such as spiced grapes, conserves, and catsup.

MEMORY

The Memory grape, discovered between 1868 and 1870 by Col. T. S. Memory at Whiteville, N. C., is valuable as an early, large-fruited, table variety. The vine is vigorous, robust, and productive. The berries are large, vinous in flavor, and dark in color. The future of this variety is as an early table grape for shipment and home use.

NEWER VARIETIES

The first plant breeder to introduce muscadine grape varieties of his own production was T. V. Munson, Denison, Tex. The list of varieties he introduced includes LaSalle, Labama, San Monta, San

Jacinto, and San Rubra. Of this group LaSalle and Labama have proved best in the Department's tests.

Director H. P. Stuckey and other workers of the Georgia Agricultural Experiment Station have conducted much breeding work with the muscadine grapes and have introduced a number of new varieties, such as the Hunt, Creek, Dulcet, Stuckey, Howard, Spalding, Lucida, Yuga, Dawn, November, and Brownie. While some of these are definitely superior sorts and promising introductions, others, though having certain good features, are of doubtful future importance.

Hunt.—Of the Georgia group the Hunt, a seedling of Flowers, has gained the most widespread popularity and has been the most planted. The vine is vigorous and very productive. The clusters are large, and the berries are black, medium-sized to large, and persistent. The skin is fairly thin; the flesh is medium tender and juicy; the sugar content and the acidity are medium. The dessert quality is good. The Hunt is a general-purpose variety for wine and table use, home plantings, and local markets.

Yuga.—The Yuga is a seedling of San Monta. The vine is vigorous and productive. The clusters are large, and the berries are light green or bronze to reddish amber, medium-sized, and very persistent. The color is variable even in the same cluster. The skin is thin; the flesh is tender and juicy; the sugar content is high and the acidity medium. The dessert quality is very good. The Yuga is a late home and local-market table grape.

Creek.—The Creek is also a seedling of San Monta. The vine is vigorous and productive. The clusters are fairly large, and the berries are reddish purple, medium-sized, and fairly persistent. The skin is thin; the flesh is juicy and has a fine fruity flavor; the sugar content and the acidity are fairly high. The Creek is a late table, juice, and wine grape.

Dulcet.—The Dulcet is a seedling of Hunt. The vine is vigorous and productive. The clusters are medium-sized; the berries are reddish purple, medium-sized, and very persistent. The skin is medium in thickness and toughness; the sugar content is fairly high and the acidity low. The dessert quality is excellent. The Dulcet ripens in midseason.

Lucida.—The vine of the selection Lucida is very vigorous and productive. The clusters are large, and the berries are greenish to bronze and very large. The skin is thick; the flesh is meaty and rather acid in flavor. Although the flavor and quality of fruit are not equal to those of some other Georgia varieties, the Lucida has commercial possibilities because of the size and appearance of the fruit.

OTHER VARIETIES

It is not possible to describe all varieties in a Farmers' Bulletin. In addition to those described, the following should also be listed as good: Luola, Smith, Hopkins, Latham, Babson, and Sugar. Other varieties of less importance are Lady James, Pee Dee, Carolina Belle, Beulah, Tender Pulp, Westbrook, and Brown. There are still other varieties, but they are relatively unknown and cannot be found in commercial nurseries.

The Bureau of Plant Industry, Soils, and Agricultural Engineering, in connection with its muscadine grape investigations, has done considerable breeding work and has tested many seedlings from this work as well as seedlings collected in the wild throughout the muscadine grape region. A circular⁵ that officially names and introduces a number of these offering the most promise has been prepared. Some of these seedlings have been distributed for testing purposes and favorable reports have been received on them, especially the Morrison, Stan-

⁵ Dearing, C. New Muscadine Grapes. U. S. Dept. Agr. Cir. 769.

ford, and Creswell. These, as well as the Kilgore, Topsail, Cape Fear, Onslow, Orton, and Tarheel and several other self-fertile hermaphrodites, are described in the circular. It is believed that a number of these varieties will prove acceptable and be planted extensively. The Topsail, for example, has been rated by those who have seen it and tried it as a better variety than Scuppernong. The several hermaphrodites being introduced will serve to replace male vines as pollinizers in vineyards, thus greatly increasing the vineyard yield per acre. They should also be of considerable help to plant breeders.

